

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

PLC Course

مقرر الحاكومات المنطقية البرمجة

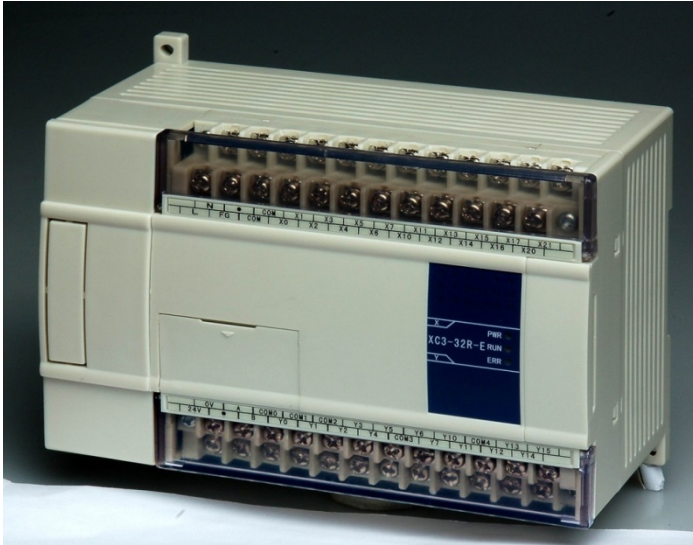
Lec 2

23/2/2016

What Is A Programmable Logic Controller (PLC)?

- A programmable logic controller (**PLC**) is an industrial computer control system that continuously monitors the state of input devices and makes logic-based decisions based upon a custom program to control the state of output devices.

Box Type



Modular or Rack Type



PLC Applications

The common applications of PLCs:

- Production lines
- Elevators
- Escalators
- Traffic Control
- Robot:
 - Toxic chemical materials spraying robot
 - Skyscrapers glass washing robot

Escalator

- Most of the time the escalator in high traffic, work at the rated operating state, in the absence of passengers is still rated speed operation, **with energy consumption (also the life time is reduced)**
- PLC control the speed of the escalator when no one take the escalator to save energy and increase the life time of it.



PLC Programming Languages

There are four programming languages that are used to program a PLC:

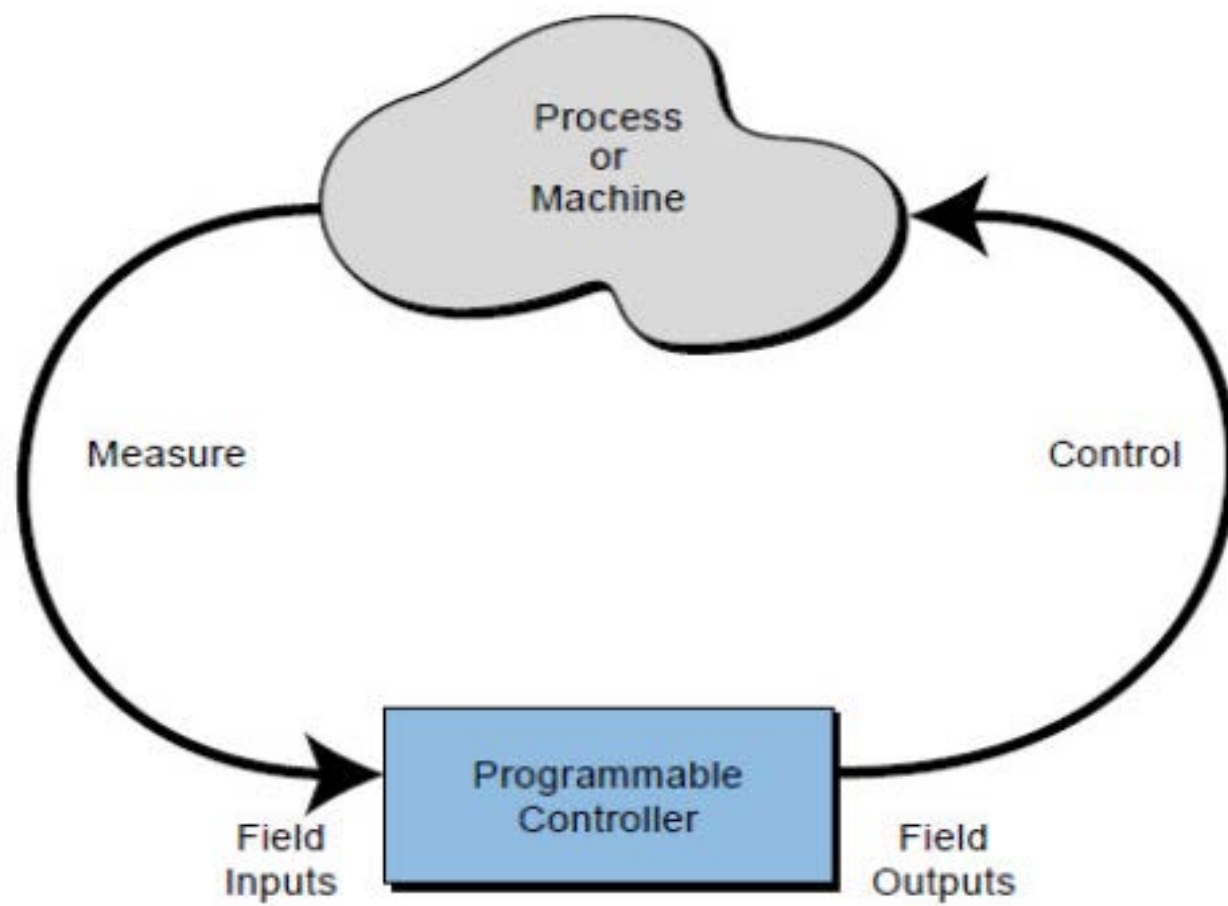
a. Ladder Diagram (LD)

b. Function Block Diagram (FBD)

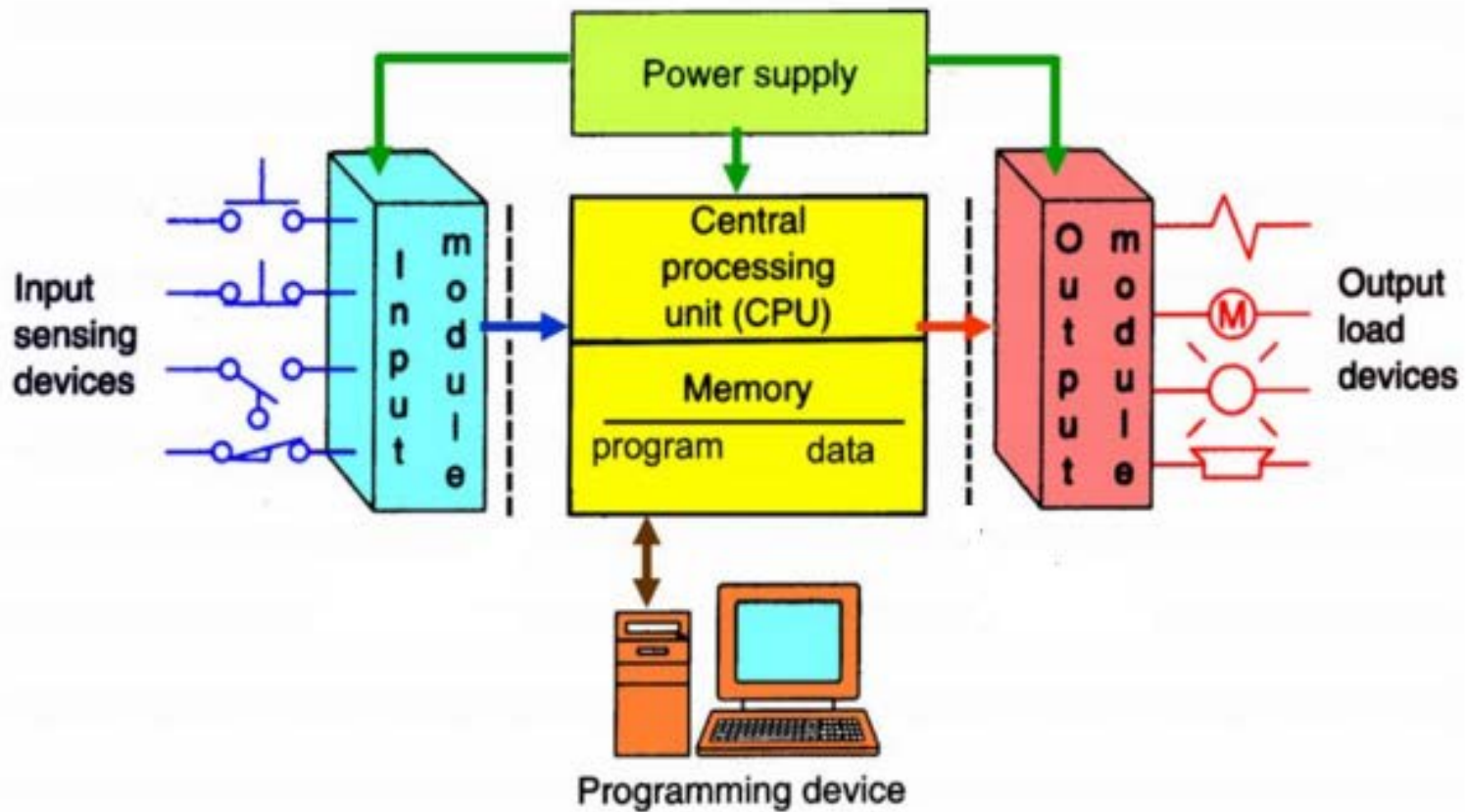
c. Structured Text (ST)

d. Instruction List (IL)

Ladder diagram is the most commonly used PLC programming language



PLC System



Main Components of The PLC

There are a wide range of PLCs sizes, but all contain **six basic components**:

- 1) Input Module (receive signals from input devices = **sensors of the PLC**)
- 2) Output Module (send the control action to output devices = **actuator of the PLC**)
- 3) CPU (Central Processing Unit)
- 4) Memory
- 5) Power Supply
- 6) programming unit, device, panel or PC/software

Memory

- The most important characteristic of a PLC is the user's ability to change the control program quickly and easily.
- The **memory** is the area in the PLC's CPU where **all of the sequences of instructions, or programs**, are stored and executed by the processor to provide the desired control of field devices.
- The memory sections that contain **the control programs can be changed, or reprogrammed**, to adapt to manufacturing line procedure changes or new system start-up requirements.
- The total memory system in a PLC is actually composed of two different memories:
 - **Executive Memory (System Memory)**
 - **Application Memory (User Memory)**

Executive Memory (System Memory)

- The **executive memory** is a collection of permanently stored programs that are considered part of the PLC itself. **These supervisory programs direct all system activities**, such as execution of the control program and communication with peripheral devices.
- The executive section is the part of the PLC's memory where **the system's available instruction software is stored** (i.e., relay instructions, block transfer functions, math instructions, etc.).
- This area of memory is **not accessible to the user (ROM Memory)**.
- The executive memory is called **system memory**



Application Memory (User Memory)

- The **application memory** provides a storage area for the **user-programmed instructions that form the application program**.
- The application memory area is composed of several areas, each having a specific function and usage.
- The application memory is called **user memory**.

Power Supply

- Its responsibility is not only to provide internal DC voltages to the system components (i.e., processor, memory, and input/output interfaces), but also to monitor and regulate the supplied voltages and warn the CPU if something is wrong.
- The power supply, then, has the function of supplying well-regulated power and protection for other PLC system components as it contains (low voltage transformer - bridge rectifier circuit – filter – regulator)
- Most PLCs, however, require a 120 VAC or 220 VAC power source, while a few controllers will accept 24 VDC.



Input Devices

- Toggle Switch
- Push button Switch
- Selector Switch
- Temperature Switch
- Limit Switch
- Liquid Level Switch
- Relay Contacts
- Photoelectric Sensors (Photo Sensors)
- Pressure Switch

Input Devices

➤ Temperature Switch:

- An inexpensive temperature-sensing mechanism is the **bimetallic strip**.
- **bimetallic strip** is a thin strip consisting of two different metals, joined face to face, each metal having a different rate of thermal expansion.
- When the strip heats or cools, different rates of thermal expansion between the two metals causes it to **bend**.
- The bending of the strip can then be used to **actuate a switch contact** mechanism.



Input Devices

➤ Limit Switches:

- These limit switches closely like toggle or selector hand switches fitted with a lever pushed by the machine part.
- Often, the levers are tipped with a small roller bearing, preventing the lever from being worn off by repeated contact with the machine part.

Input Devices

➤ Liquid Level Switch:

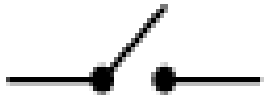
- A floating object can be used to actuate a switch mechanism when the **liquid level** in a tank rises past a certain point.
- Level switches can also be designed to detect the level of **solid materials** such as wood chips, grain, coal, or animal feed in a storage silo, bin, or hopper.



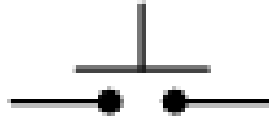
Input Devices

➤ Pressure Switch:

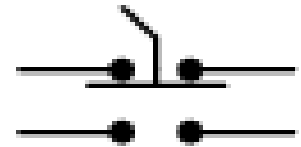
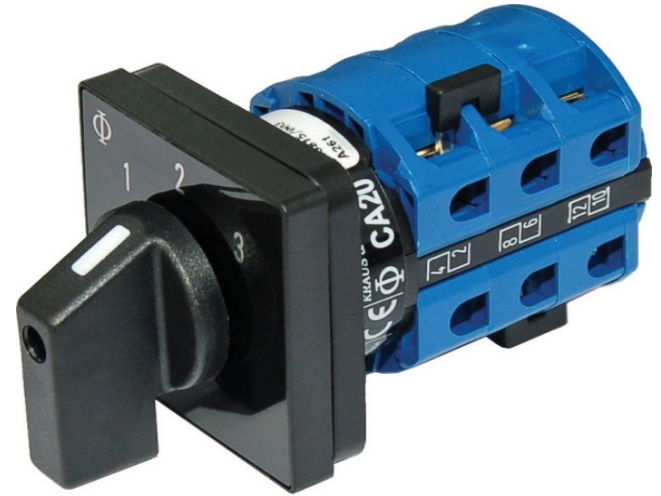
- Gas or liquid pressure can be used to actuate a switch mechanism if that pressure is applied to the switch , it **converts pressure to mechanical force**.
- The mechanical force can then be used to **actuate a switch contact** mechanism.



Toggle Switch



Push Button Switch



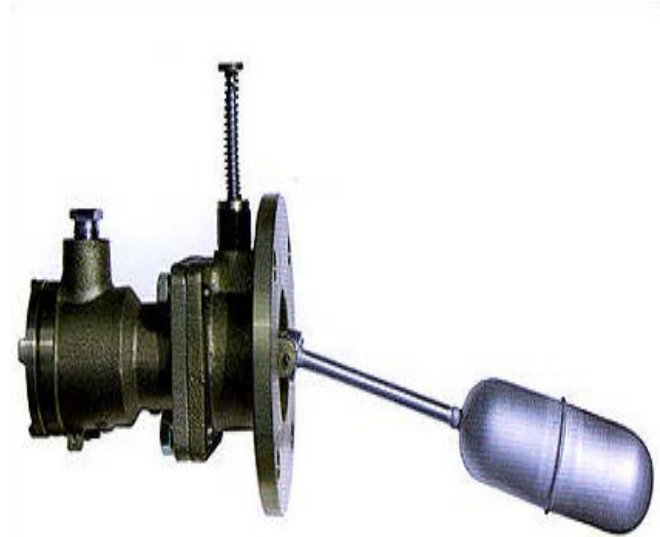
Selector Switch



Temperature Switch



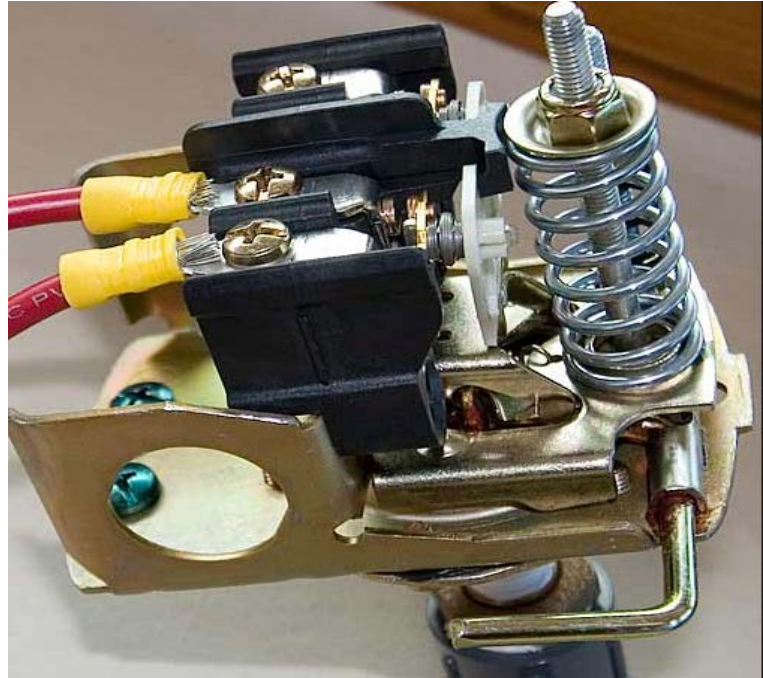
Limit Switch



Liquid Level Switch



Photo Sensor



Pressure Switch





Output Devices

- Control relays (CRs)
- Motor
- Solenoids
- Valves
- Alarms
- Fans
- Lights

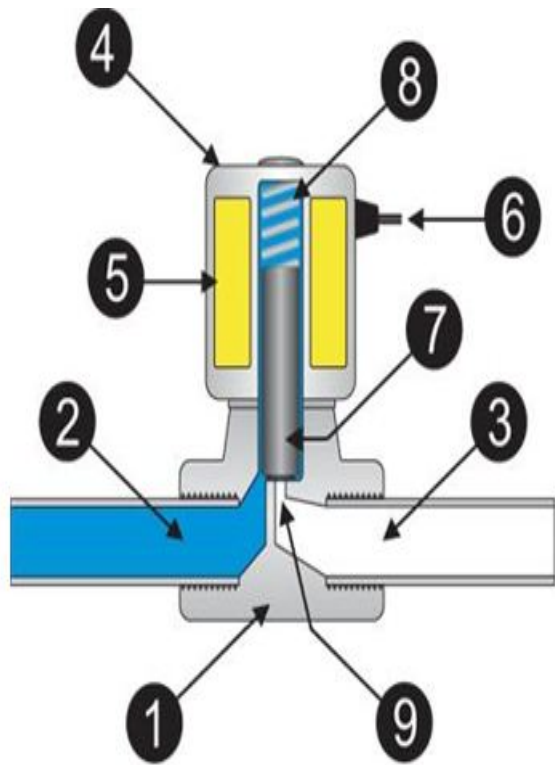
Output Devices

➤ Solenoids

- A solenoid is an **electromechanical device** which allows for an electrical device to **control the flow of a gas or liquid (valves)**.
- The electrical device causes a current to flow through a coil located on the solenoid valve.
- This current flow in turn results in **a magnetic field** which causes the displacement of a metal actuator.
- Electromagnetic solenoids are used in **hotel door locks, water-pressure valves and in air conditioning systems**.



Solenoid basic wired coil



Parts of Solenoid Valve

- 1) Valve body
- 2) Inlet port
- 3) Outlet port
- 4) Coil / Solenoid
- 5) Coil winding
- 6) Lead wires
- 7) Plunger or piston
- 8) Spring
- 9) Orifice

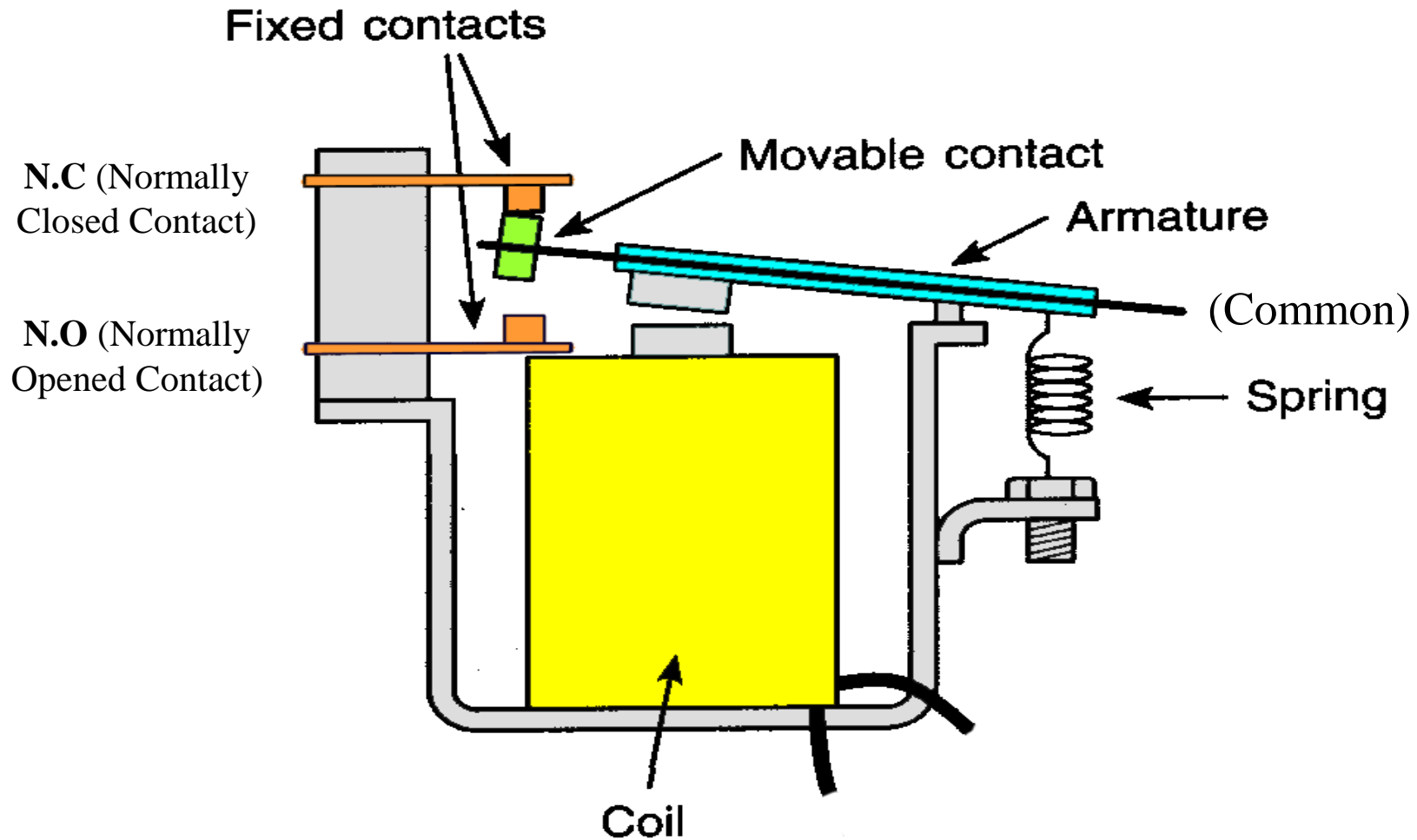


Solenoid Valve



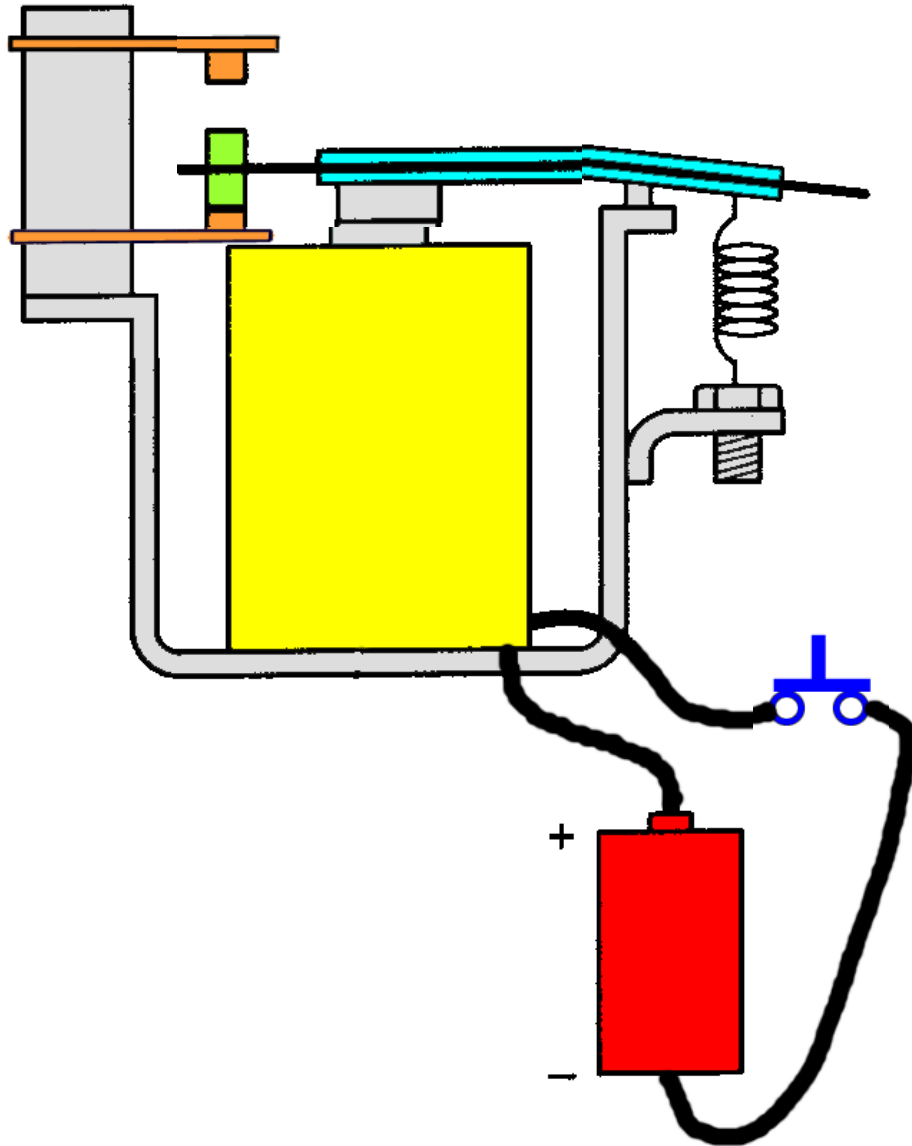
Output Devices

- Control Relay (Electromagnetic Relay):
 - An electromagnetic relay is a magnetic switch. It uses electromagnetism to switch contacts.
 - A relay will usually have **only one coil but may have any number of different contacts.**



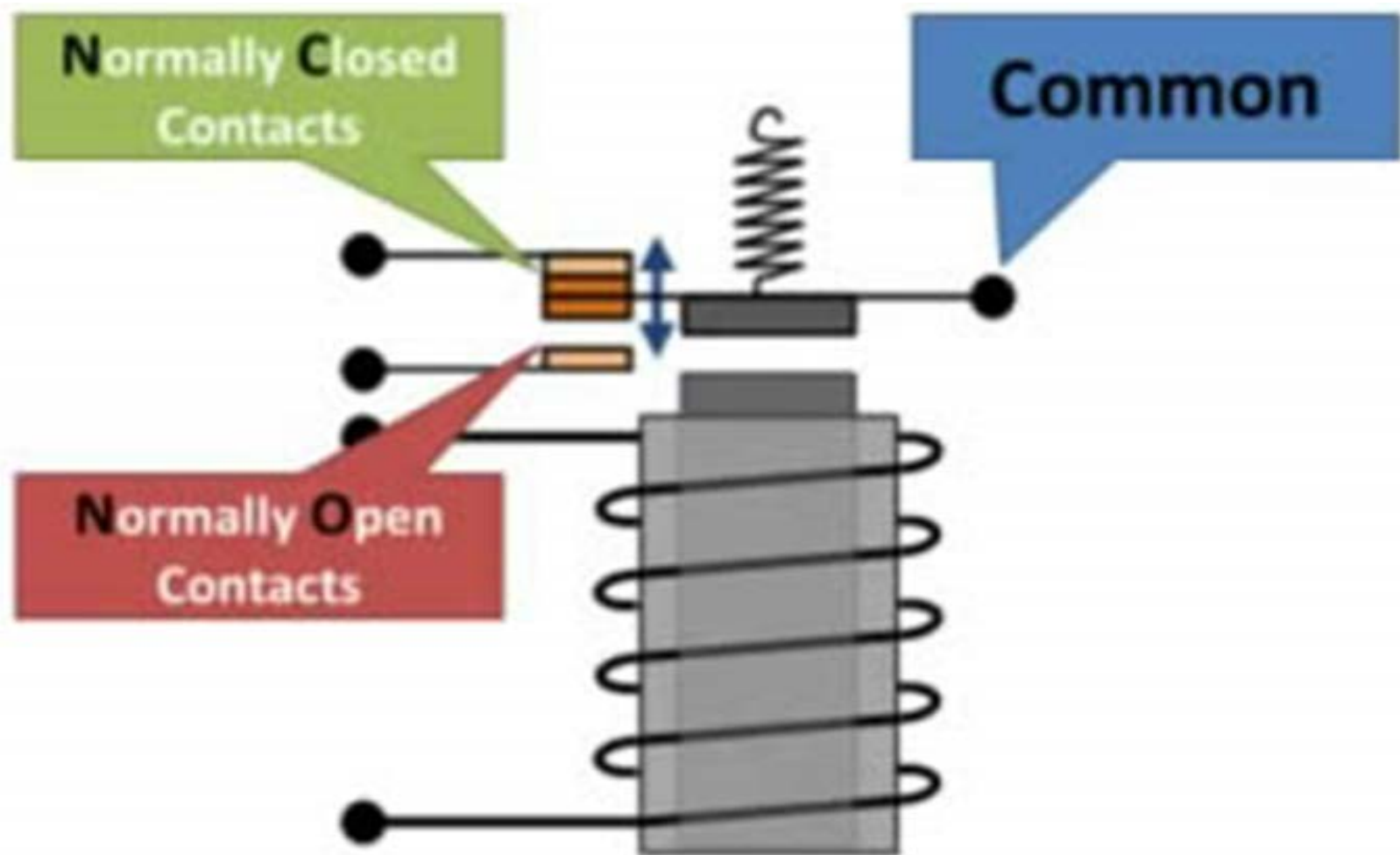
Electromagnetic Relay

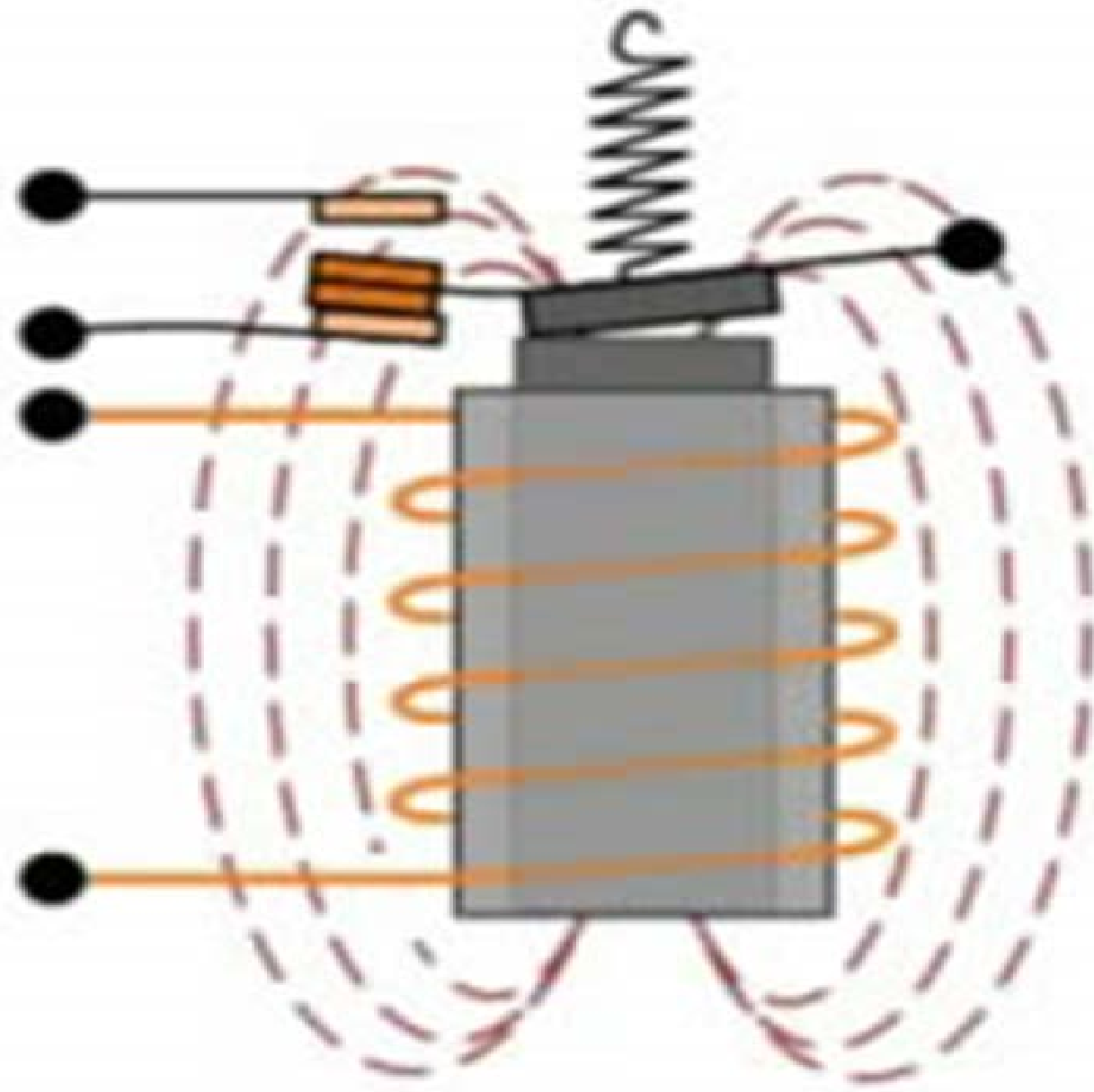
Relay Operation

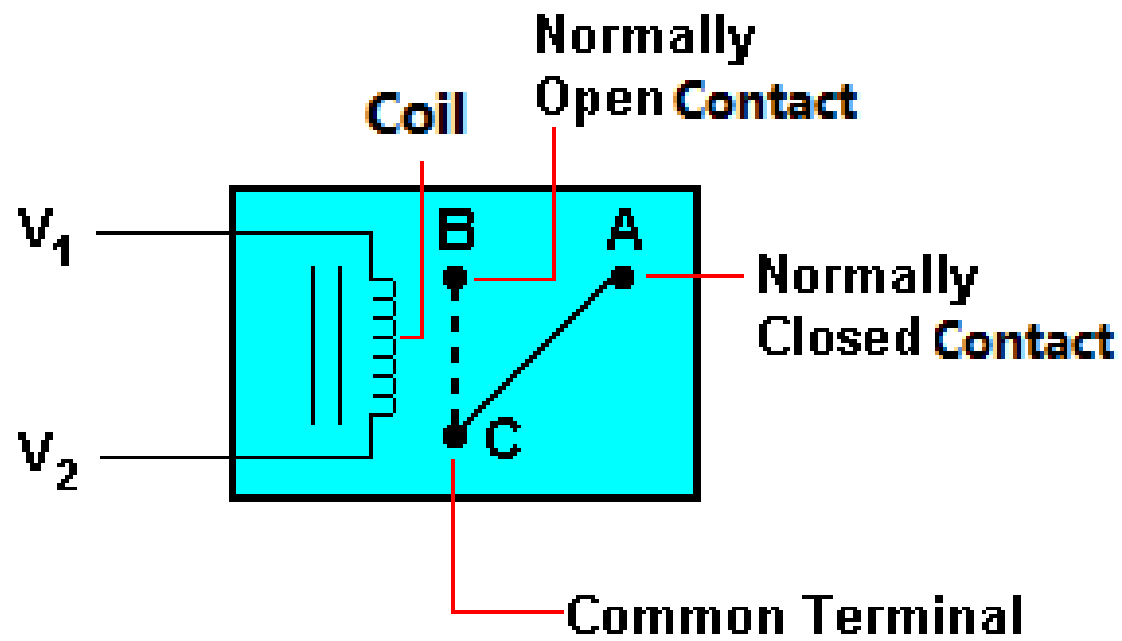


With no current flow through the coil (the coil is de-energized), the armature is held away from the core by spring tension.

When the coil is energized, the electromagnetic field moves the armature causing the contact points of the relay to open or close.

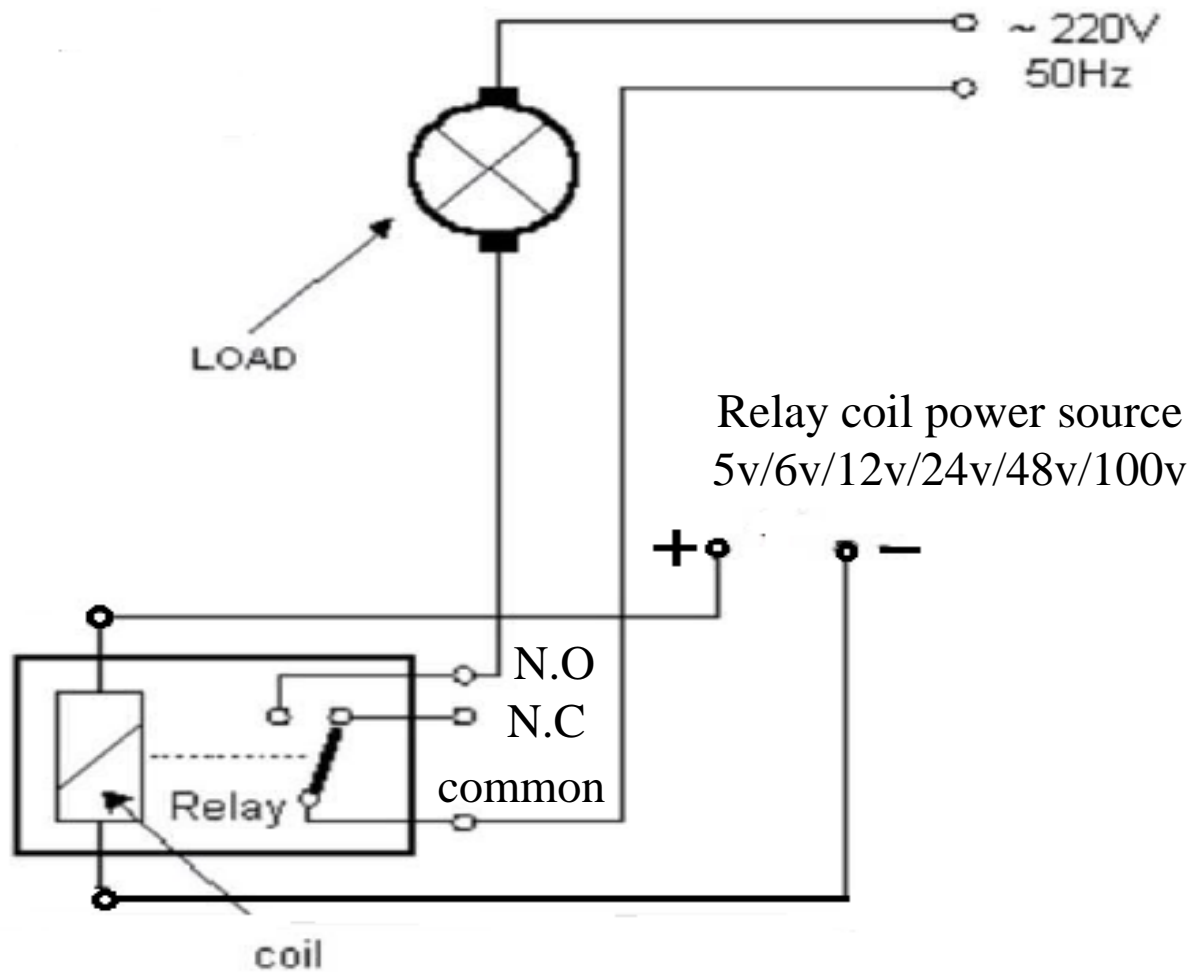








Physical Relay with three different contacts

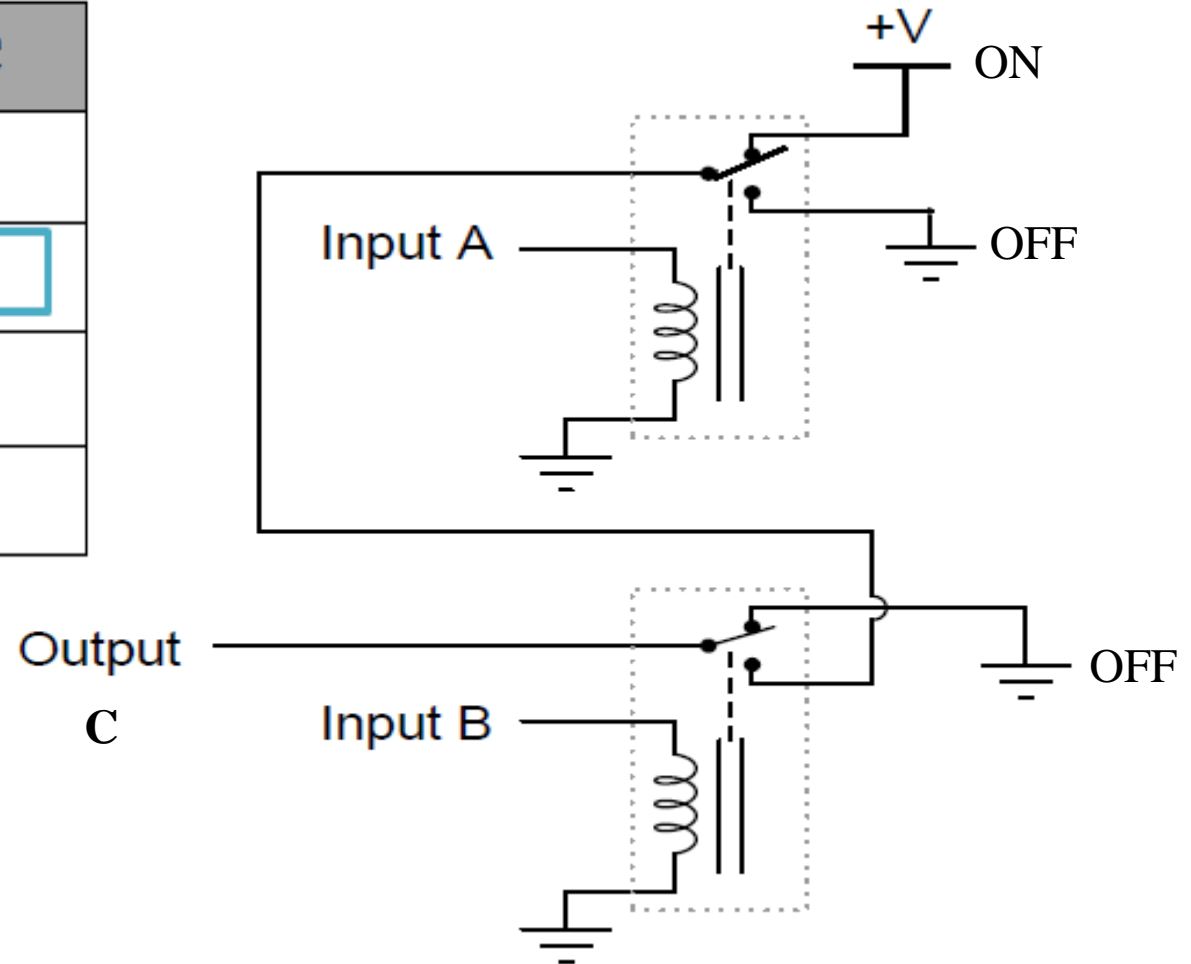


Relay Connection with A 220v Device/Load

Example1: writ the truth table for the following relay circuit

A	B	C
0	0	0
0	1	1
1	0	0
1	1	0

$$C = A / B$$



Example2: writ the truth table for the following relay circuit

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

$C = (A \cdot B) /$
NAND gate

